

AMERICAN MUSEUM Novitates

PUBLISHED BY THE AMERICAN MUSEUM OF NATURAL HISTORY
CENTRAL PARK WEST AT 79TH STREET, NEW YORK, N.Y. 10024
Number 2887, pp. 1-13, figs. 1-20

July 22, 1987

Nesting Biology and Immature Stages of a New Species in the Bee Genus *Hesperapis* (Hymenoptera: Apoidea: Melittidae: Dasypodinae)

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ABSTRACT

This paper describes *Hesperapis* (*Hesperapis*) *trochanterata* Snelling, new species, from southern Arizona, and provides data on various aspects of its nesting biology, including: description of nest site, nest architecture, provisioning, and development of immatures. Mature larva and pupa are

described. The food source, *Nama hispidum*, is identified, and special adult features used in foraging and nest excavation are discussed. A brief note is also presented on the nesting behavior of females of *H. (Carinapis) rhodocerata* (Cockerell).

INTRODUCTION

This paper presents information on the nesting biology and floral preferences of *Hesperapis trochanterata*, n. sp., described herein by R. R. Snelling. I also illustrate, describe, and compare the mature larva with larvae of other known species in the subfamily Dasypodinae (Rozen and McGinley, 1974). In addition, I present the first published description of any pupa of the Dasypodinae.

The genus *Hesperapis* is restricted to xeric western North America (except for one species in Florida) and is especially abundant in the southwestern United States and undoubtedly

also northern and central Mexico. It is closely related to *Capicola* (southern Africa) and *Xeralictoides* (western United States) (Michener, 1981). A number of papers have been published on the natural history of one or another of its species, including: Hurd (1957) (unusual seasonal occurrence of *H. fulvipes* Crawford); Linsley and MacSwain (1958) (sleeping habits of males); Burdick and Torchio (1959) (nesting biology and floral relationships of *H. regularis* (Cresson)); MacSwain et al. (1973) (floral relationships, seasonal activity, mating, nesting biology of

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Fig. 1. Nesting site of *Hesperapis trochanterata*. Most nests' entrances were in the barren sand at the periphery of the clearing of the *Pogonomermyx* nest in center.

H. regularis); and Hurd and Linsley (1975) (floral relationships). Rozen (1974) briefly described the nesting biology of the southern African *Capicola braunsiana* Friese (Dasy-podini) and *Haplomelitta ogilviei* (Cockerell) (Sambini).

The mature larvae of *Hesperapis* have been described by Michener (1953) (*H. rufipes* (Ashmead)), Burdick and Torchio (1959) (*H. regularis*), and Rozen and McGinley (1974) (eight species of *Hesperapis* as well as *Capicola braunsiana*).

Although there is at present no comprehensive account of the biology of the genus, G. I. Stage undertook a major study of the nesting biology of a number of species of *Hesperapis* as a part of his Ph.D. thesis. The manuscript, currently being revised and expanded by Stage and Snelling (MS), will indeed provide a broad understanding of the natural history of the genus. The description of the biology of *Hesperapis trochanterata* has been arranged in this paper to be comparative with information they present.

ACKNOWLEDGMENTS

I thank G. I. Stage and R. R. Snelling for the opportunity to study their manuscript on *Hesperapis*. The following persons critically reviewed this manuscript: Ronald J. McGinley, Smithsonian Institution; R. R. Snelling, Los Angeles County Museum of Natural History; and G. I. Stage, Stafford Springs, Conn. I acknowledge their assistance with gratitude.

NATURAL HISTORY

NESTING AREA: This species flew in moderate numbers on May 8, 1986, at 4 mi east of Willcox, Cochise County, Ariz., several hundred meters from where nests of *Martinapis* and *Caupolicana* had been discovered in August 1985 (Rozen and Rozen, 1986). The area (fig. 1) consisted of partly tied down sand dunes, derived from the Willcox playa several miles away. Vegetation stabilized the fine sand except for scattered blowouts resulting from grazing cattle and the clearing

activities of harvester ants (*Pogonomyrmex*). Mesquite (*Prosopis*), the dominant tree, was scattered and much of the ground surface was exposed to the sun except for low growing shrubs and such herbaceous plants as *Eriogonum*, *Euphorbia*, and *Nama hispidum* A. Gray, the pollen plant of the bee (kindly identified by James Grimes of the New York Botanical Garden). *Nama* grew abundantly in patches within a radius of several hundred meters of the nesting areas and was visited by *Conanthalictus* as well as *Hesperapis trochanterata*.

I identified a number of nest entrances in a barren, sandy area on May 8, 1986, and excavated them on May 15 and 16 at which time I found entrances in adjoining open areas on the edges of *Pogonomyrmex* clearings (fig. 1). Subsequent visits to the region in August and early September 1986 revealed activity in these same areas, and I discovered an additional site about a mile away.

NESTS: Four nest groups were discovered in May, all on surfaces of loose, wind-blown sand that were gently sloping (10–20°), unshaded, and nearly barren.

At each site the nest entrances were irregularly distributed and could usually be identified by their size and by the characteristic tumulus (described below) of darkened sand (when fresh). Although I excavated only four or five active nests (i.e., nests with fresh tumuli), other main burrows became evident once I had removed the surface layer (3–4 cm thick) of soft sand to expose the more consolidated substrate of fine sand below. It is unclear whether these other burrows were nests from previous generations, more recent nests from which the tumuli had been blown away, or both. However, cells (both recently constructed and containing quiescent, post-defecating larvae) subtended them. For every active nest identified on the surface, three to five burrows were hidden below in the compact sand, within a radius of 30 cm of the fresh nest. Certainly the tumuli of fine, dry sand, as well as the entrance holes, would be ephemeral landmarks if the females did not regularly reestablish them.

Entrances (fig. 2), which penetrated the surface at a low angle, were semicircular (rather than circular) in shape, and the tumuli occurred mostly on the downhill sides. Each

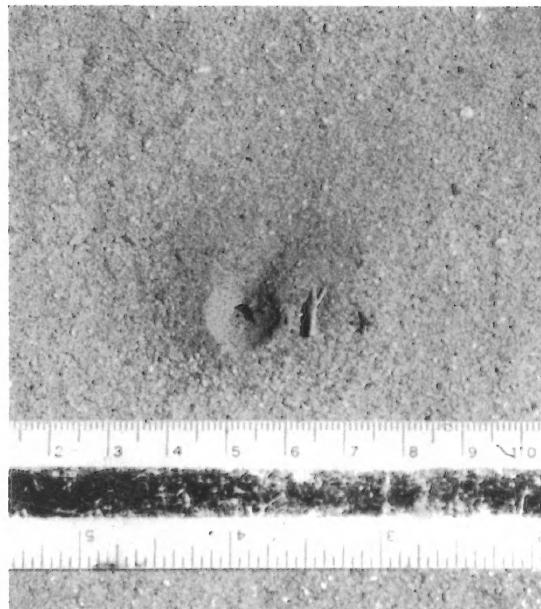
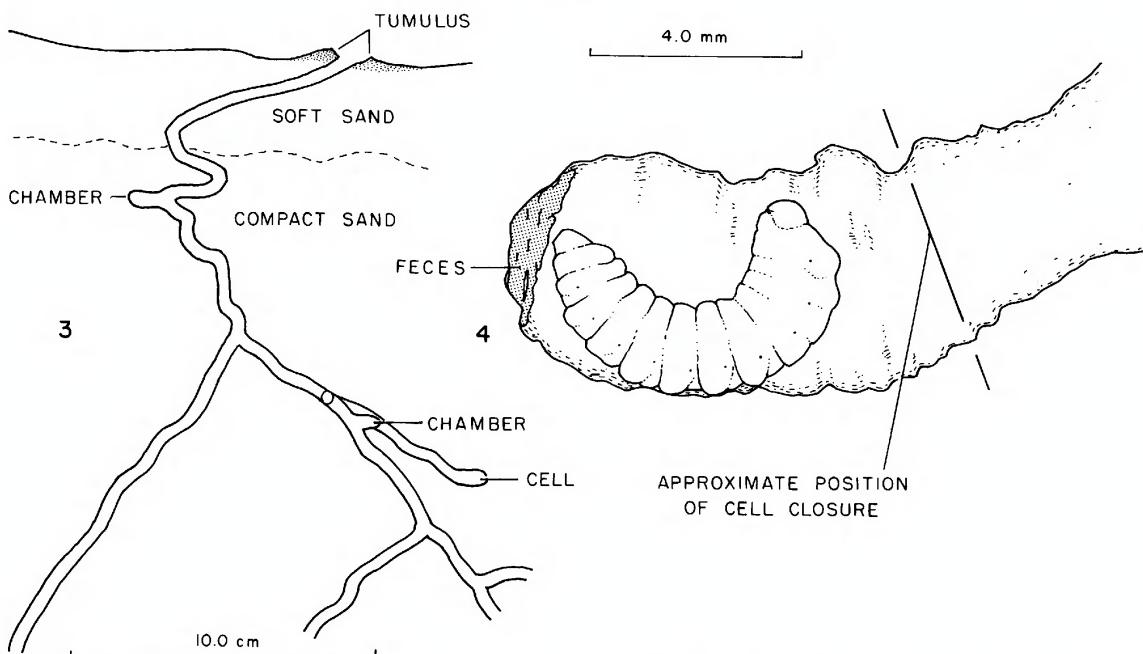


Fig. 2. *Hesperapis trochanterata*, nest entrance showing characteristic tumulus.

tumulus, generally 2.5–3.0 cm in diameter, was low, cratered at the entrance, and gradually merged with the substrate surface. In contrast, nest entrances of other species of bees consisted of mounds in sharp relief where females piled excavated material just outside the entrance.

At the one nest group excavated, the open burrows (fig. 3), 3–4 mm in diameter, extended obliquely through this upper loose sandy layer at about a 20–30° angle from horizontal and were straight to curved. In the consolidated soil below, they descended vertically in a twisting fashion. Open above, they branched, with each meandering ramus descending at approximately a 45° angle. The rami tended to be clogged with loose soil that could be blown away with an aspirator at upper levels. However, at lower levels the substrate became faintly moist as did the fill of the branches, with a result that I could not remove the fill by blowing and I lost the tunnels. Although not carefully noted, burrow diameters did not seem to be narrower at lower levels than at upper ones, as reported for some species of *Hesperapis* by Stage and Snelling (MS).

At various points along the tunnel system arose small chambers, perhaps 5–10 mm long,



Figs. 3, 4. *Hesperapis trochanterata*, nest components. 3. Side view of upper section of nest. 4. Cell containing postdefecating larva and feces.

as wide as or slightly wider than the tunnel itself, and rounded at the blind end. The function of the cul-de-sacs is uncertain in view of the fact that only one female occupied a nest. Neither these chambers, the main tunnel, nor its branches were lined and waterproofed, and their walls were generally rough.

I encountered cells infrequently in the upper levels of nests, the most shallow one being 9.5 cm deep and two others 13 cm deep. However, most cells of both active nests and nests containing postdefecating larvae occurred at a depth of approximately 23–27 cm (N = 8). All were arranged singly, as is characteristic of the genus, and were nearly horizontal, with the front end slightly higher than the rear. In the related *Capicola*, cells are arranged in linear series and in *Haplomalittia*, singly (Rozen, 1974). Because tunnels leading to lower cells could not be traced, I had to chip through large quantities of substrate to chance upon them. The several cells at shallow depths connected to the main tunnel by descending laterals that curved gradually horizontally.

Cells (fig. 4) were elongate ovals with a round rear end. Their walls were completely

uncoated, nonwaterproof when tested with water droplets, and of the same hardness as the substrate. Simple cavities excavated from the substrate, they had a rough texture and bore the faint, but characteristic, impressions of annular ridges perpendicular to the cell's long axis. A rough wall, unlined either with secretions or with material transported from the outside, is uncommon among ground-nesting bees, but is known for some other *Hesperapis* (Stage and Snelling, MS).

Two cells measured approximately 8 and 9 mm in length and two, 4.0 and 4.5 mm in maximum diameter. The entrance to one was 3.0 mm in diameter with the lateral filled with loose soil that was blown away. The configuration of the cell closure remains unknown.

PROVISIONING: Females of *Hesperapis trochanterata* possess abundant, long setae on the stipes and prementum that are probably used to pull pollen from the tubular flowers of *Nama*. The stipital setae are wavy to almost kinky apically, and are nearly identical to long, wavy setae that border the proboscisid fossa laterally and posteriorly. The premental setae tend to be shorter, curved api-

cally, and directed somewhat posteriorly. The head of both sexes is elongate and has a projecting clypeus—presumably adaptations that permit the bee to gather food from this plant by reaching deeply into the flowers. Males do not have the specialized long wavy or curved setae on the mouthparts.

Females transported provisions as moist pollen attached to the anterior surface of the hind tibiae. The elongate curved dorsal setae characteristic of the hind tibiae of this species were not involved with the provisions. Females molded the yellow provisions into spheres 2.1–2.4 mm in diameter ($N = 5$) and placed them on the floor of the cells. The spheres were homogeneously moist, very firm, and uncoated by waterproof material, in contrast to the coated spherical food mass of certain panurgines. One incomplete food mass, a small ball, was also spherical but more uneven than the completed mass.

DEVELOPMENT: I uncovered a single, strongly curved, shiny, translucent white egg (maximum diameter 0.45 mm; length 1.55 mm) on top of the provisions in the median sagittal plane of the cell. Its anterior end was distinctly wider than the more tapering posterior end. Although I saw several small feeding larvae, they died and desiccated before I had a chance to study their behavior. Postdefecating larvae (fig. 4), totally quiescent, rested on their dorsa with their heads pointed toward the cell exits. Of five postdefecating larvae kept live, two pupated before May 31 and the rest were preserved. The pupa developed rapidly, as is characteristic of all bees, and were preserved for anatomical description.

Feces (fig. 4), deposited in a patch in the upper rear of the cell, consisted of elongate pellets running generally parallel to the sagittal plane of the cell. These bees did not produce cocoons, and the labiomaxillary region of the mature larva was greatly recessed, as is characteristic of all Dasypodinae (Rozen and McGinley, 1974).

The integument of the postdefecating larva of this species was peculiar in that falling fine sand from my excavation readily adhered to it even though it did not appear moist. When I removed sand from preserved specimens by gently scraping with forceps, not only the sand but patches of thin, tannish, semitrans-

parent integumentlike material flaked from the white larva beneath. This material evenly coated the entire integument and showed all of the contour features of the body wall. It was fairly rigid, whereas the true integument beneath was more pliable. Spiracular openings were not coated. I have noticed similar coatings on larvae of some other noncocoon spinning bees (for example, certain nomadines). The coating dissolved when boiled in a solution of potassium hydroxide, an indication that it is not chitinous. Its source is unknown but it is apparently laid down (at least in the Nomadinae) at about the time the larva enters diapause, perhaps as a protection against desiccation or parasites.

Each pupa (fig. 13) was extremely active in that it rotated its metasoma by flexing it at the base so that the tip of the metasoma circumscribed a circle. When placed in an excavated cell, a pupa used the apical metasomal spine as a posterior pivot against the rear of the cell and the pronounced vertical tubercles and labral tubercles (see description of pupa) as anterior pivots against the front cell wall. When the midpart of the dorsum arched upward as a result of metasomal flexing, the dorsal metasomal tergal tubercles came in contact with the cell wall, and when the midpart of the body was arched downward, the sternal metasomal tubercles scraped the cell wall. Of course, in a sealed cell in the ground the metasoma is not arched just upward and downward, but in all directions as a result of its rotating action. The result must be that the top, bottom, and sides of the wall are contacted by the gyrating metasoma. The function of this rotation is not understood, but would seem to be significant when one considers the number of special anatomical features involved in performing the motion. Possibly the metasomal tergal and sternal tubercles with their pigmented sclerotized tips scrape parasites and predators (such as mites) against the cell wall. Alternatively, the tergal and sternal tubercles may merely assist in rotating the body in the cell, their sclerotized tips providing traction against the cell wall. Rotation of the abdominal areas of pupae of holometabolous insects is, of course, widespread.

ADULT BEHAVIOR AND SPECIAL FEATURES: Adults were active during midday, first flying

in midmorning. Males commonly flew swiftly over the low-growing food plant. They suddenly landed on the ground and then just as suddenly departed, darting from one clump of *Nama* to the next. Although I saw no matings, copulation almost certainly took place either at the flowers or at the base of the flower plants. Males did not search for females in the nesting areas.

At nesting areas I saw females land and start to enter the substrate by scratching with their forelegs, only to depart quickly as if they did not find the area suitable. Several females were observed excavating tunnels by digging with their forelegs and flinging the excavated sand backwards with the hind legs in such a rapid motion that the hind legs seemed to blur. The resulting shower of sand created the tumulus described above.

The hind legs of the females possessed long, curved, thick, simple dark setae that undoubtedly assisted in sand flinging. Especially, these setae on the hind basitarsus arranged in two even rows created a trough that cupped the sand to be flung similar to the adaptations of the hind legs of the unrelated *Neofidelia* (Rozen, 1973). In *Hesperapis trochanterata* the setae of one row are directed posteriorly, those of the other row, dorsally. In *Neofidelia*, the hairs in each row are directly obliquely dorsally so that the setae of the two rows diverge apically.

At 2 mi southeast of Willcox, I observed nearly identical sand flinging on the part of nesting females of *Hesperapis* (*Carinapis*) *rhodocerata* (Cockerell), midday, on September 5, 1986. These females also exhibit the troughlike arrangements of setae on the hind basitarsus, as described for *H. trochanterata*. Since specimens of some species of *Hesperapis* possess these modifications and others do not, one can test the hypothesis that the troughlike setal arrangement is an adaptation for sand flinging by learning how species without the modifications discharge soil from nests.

Not only are there similarities between *Neofidelia*, *Hesperapis trochanterata*, and *H. rhodocerata* with respect to modifications of the hind tarsi involved with sand flinging, but also the taxa share enlarged pygidial plates. These anatomical similarities may be associated functionally in some way with nesting

in sandy situations. Reduction (*Neofidelia* and *Fidelia*) or loss (*Hesperapis trochanterata*, *Parafidelia*, and some *Fidelia*) of basitibial plates on the hind legs of females may also be involved with sand nesting, but *H. rhodocerata* possesses well-developed basitibial plates.

I found two females of *Hesperapis trochanterata* to possess three ovarioles in each ovary (ovariole formula 3:3), as is characteristic of other Melittidae (Rozen, 1986).

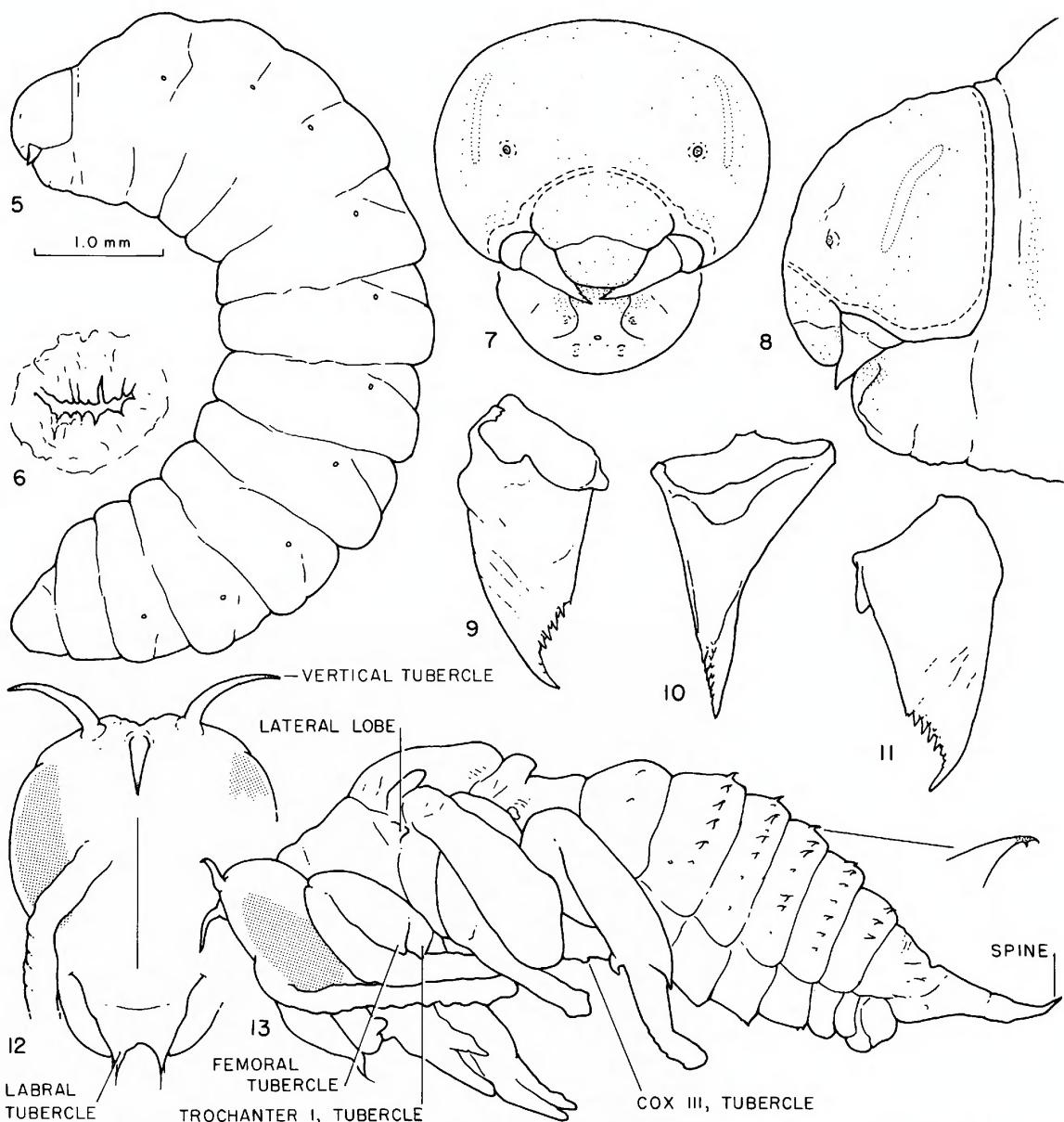
I have collected this *Hesperapis* in the vicinity of Willcox, Arizona, in both May and again in mid-August to mid-September not only in 1986, but in previous years. The data seem to indicate that the species has at least two generations a year, but the site needs repeated observations through the growing season to provide a clear understanding of voltinism and seasonal activity.

PARASITISM: No cuckoo bees visited the nesting area and no cuckoo bee larvae or other nest associates or parasites were found in the cells.

DESCRIPTION OF POSTDEFECATING LARVA

Figures 5-11

DIAGNOSIS: This is a small species (length of postdefecating larva 5–6 mm), apparently closely related to *Hesperapis* species b (Rozen and McGinley, 1974) as judged by characteristics of adults (and supported by features of the larvae). Its larva can be distinguished from all known larvae of *Hesperapis* including *Hesperapis* species b on the basis of the following combination: Epistomal ridge incomplete, fading abruptly medially; area immediately behind junction of hypostomal ridge and posterior thickening of head capsule not greatly swollen; anterior part of head capsule as seen in lateral view (fig. 8) evenly curved, not depressed; dorsal inner edge of mandible (figs. 9–11) with only a few large teeth in addition to a number of much smaller teeth. The larva of this species can further be distinguished from that of *Hesperapis* species b (to which it bears a strong resemblance) by its distinctly longer, tapering, mandibular apex (figs. 9–11). As pointed out by Rozen and McGinley (1974), all known *Hesperapis* larvae can be distinguished from



Figs. 5-13. *Hesperapis trochanterata*, immatures. 5. Postdefecating larva, live, lateral view. 6. Perianal area of larva. 7, 8. Head of postdefecating larva, frontal and lateral views. 9-11. Right mandible of postdefecating larva, dorsal, adoral, and ventral views. 12. Head of pupa, frontal view. 13. Pupa, lateral view. Scale refers to figures 5 and 13.

those of *Capicola* because the former lack paired dorsal tubercles. Interestingly, the in-trasegmental lines on abdominal sterna IX and X may be absent in *H. trochanterata*, as is also the case for *Capicola*.

HEAD (figs. 7, 8): As described for genus *Hesperapis* and *Hesperapis pellucida* Cock-

rell (Rozen and McGinley, 1974) except for the following: Integument strongly crinkled so that sensilla and spiculation pattern difficult to detect. Epistomal ridge well developed but briefly and completely interrupted medially; ridge more arched than in *Hesperapis pellucida* but not quite reaching level of

antennae. Antennal papilla not strongly produced. Apical section of labrum scarcely emarginate if at all. Mandible similar to that of *Hesperapis* species b: cusp moderately well defined and very few teeth extending apically along dorsal adoral surface; dorsal apical edge with only a few, enlarged teeth; ventral apical edge without teeth; apex of mandible in general longer and more attenuate than that of *Hesperapis* species b.

BODY: As described for the genus *Hesperapis* (Rozen and McGinley, 1974) except for the following: Integument of postdefecating forms strongly wrinkled, mostly nonspiculate. Form (fig. 5) moderately slender. Abdominal segment IX with venter essentially normal length, not greatly elongate as in some *Hesperapis*; abdominal sternum IX apparently without intrasegmental line; abdominal sternum X either without intrasegmental line or at least with line obscured in postdefecating form; segment X perhaps somewhat elongate; perianal area (fig. 6) nearly circular and puckered. Spiracular elevations not pronounced. Male with median cuticular scar toward rear of abdominal sternum IX; female sexual characters unknown.

MATERIAL STUDIED: Four postdefecating larvae, 4 mi E Willcox, Cochise County, Ariz., 16 May 1986 (J. G. Rozen).

DESCRIPTION OF PUPA

Figures 12, 13

The following is believed to be the first formal description of a pupa for any member of the Dasypodinae, although Stage and Snelling (MS) give accounts of two other *Hesperapis* pupae. In regard to other melittids, Rozen and McGinley (1974) described the pupae of *Melitta leporina* (Panzer) and *Macropis europaea* Warncke (Melittinae); Rozen and Jacobson (1980) found the pupa of *Macropis nuda* (Provancher) to be identical to that of *Macropis europaea*. Rozen (1977) figured and described the pupa of *Meganomia gigas* Michener (as *M. binghami*) (Meganomiinae).

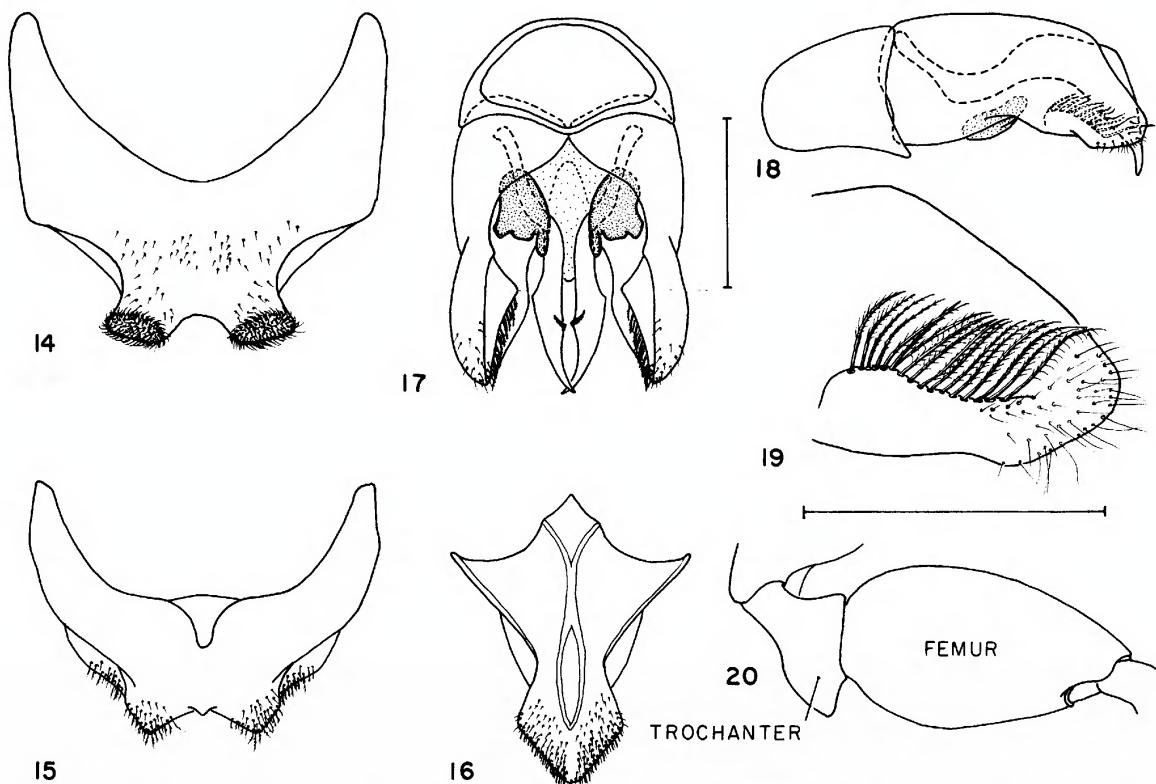
DIAGNOSIS: The pattern, size, and shape of pupal tubercles of the known representatives of the Melittidae appear distinctive from one subfamily to the next. The conspicuous vertical tubercles and elongate terminal spine of

the pupa of *Hesperapis trochanterata* immediately distinguish it from the pupae of *Melitta*, *Macropis*, and *Meganomia*, all of which lack such structures. The paired apical labral tubercles with their elongate darkly pigmented setiform apices and the peculiar bidentate dorsal metasomal tubercles are also unique characteristics of this species. Information given by Stage and Snelling (MS) indicate that the pupal features of *Hesperapis trochanterata* do not apply completely to several other species of *Hesperapis*.

HEAD: Integument without setae or spicules. Vertex (figs. 12, 13) with three elongate, sharp-pointed, apically pigmented tubercles, each arising from position of ocellus; each tubercle with slight irregular constriction at base. Antennae without tubercles. Genal tubercles present behind mandibular base. Labrum (fig. 12) bearing two apical tubercles, each of which bears elongate setalike, darkly pigmented tapering projections as well as one or two subapical somewhat shorter setalike projections. Mandible with conspicuous ventral tubercle. Maxilla swollen at base to accommodate stipital setae of adult.

MESOSOMA: Integument without setae or spicules. Lateral angles of pronotum not produced; posterior lobe of pronotum moderately produced and apically acute; mesepisternum without tubercles; mesoscutum without tubercles; axilla not produced and scarcely discernible; scutellum at most vaguely produced on each side; metanotum slightly produced medially; propodeum without tubercles. Tegulae and wings lacking tubercles. Fore- and midcoxae each with small apical tubercle; hind coxa with minute apical tubercle; each trochanter with moderately small apical tubercle; forefemur with basal tubercle; hind tibia with elongate apical tubercle on outer edge; legs of male and female approximately same in shape and configuration in spite of modified hind legs of adult male.

METASOMA: Integument without setae. Terga I–VI (male) and I–V (female) each with subapical row of moderately small, apically pigmented tubercles; larger tubercles curving posteriorly and each bearing subapical tooth; smaller ones apically simple; terga without median around tubercles as found in *Meganomia*; sterna IV–V (male) and III–V (fe-



Figs. 14-20. *Hesperapis trochanterata*, adult male. 14-16. Metasomal sterna 6-8. 17, 18. Genital capsule, ventral and lateral views. 19. Inner view of apex of gonostylus. 20. Metatrochanter and metafemur. Scale = 0.50 mm, except figure 19 = 0.25 mm.

male) each with apical row of small tubercles with simple, darkly pigmented, sharp-pointed apices. Terminal spine greatly elongate, sharp pointed, bearing pigmented apex.

MINERAL STUDIED: One male pupa, 4 mi E Willcox, Cochise County, Ariz., collected as postdefecating quiescent larva, 16 May 1986, pupated 25 May 1986, preserved 28 May 1986 (J. G. Rozen); one female pupa, same data except pupated 30 May 1986, preserved 2 June 1986.

APPENDIX

Description of *Hesperapis (Hesperapis) trochanterata*, new species

BY R. R. SNELLING
Figures 14-20

This species is described in advance of a forthcoming revision of *Hesperapis*, by G. I.

Stage and R. R. Snelling (MS), in order that Rozen may describe the nesting biology and immature stages. Stage had seen a few specimens of this species from Texas (and recognized that it was new), but did not include it in his thesis (Stage, 1966).

The following description is patterned after those in the *Hesperapis* revision in order to facilitate future comparisons.

DIAGNOSIS: The male differs from those of all others in the nominate subgenus (sensu Michener, 1981)—including known, undescribed species, as well as those of all other subgenera—by the swollen pro- and metafemora (fig. 20) and especially by the presence of a coniform tubercle on the ventral surface of the metatrochanter. Within the subgenus *Hesperapis*, the female may be separated from *H. elegantula* Cockerell and one undescribed species by the longer than broad head (length no more than 0.90 times width in those species); from the one remaining species (un-

described, from Nevada) the female of *H. trochanterata* may be separated by the uniformly convex clypeal disc, the completely roughened and dull propodeal triangle, and the dark, long simple hairs of the metatibia. (In the Nevada species, the clypeal disc is distinctly impressed along the midline, the propodeal triangle is roughened only in the middle and very narrowly along the anterior margin, and the long, simple hairs of the hind legs are yellowish.)

FEMALE: Measurements (mm). Head width 1.45; head length 1.52; body length 4–6.

Head: Integument shiny black except for light brownish labrum and reddish mandibles; underside of flagellum yellowish red. Vestiture entirely silvery whitish, except very long hairs in ocellar area slightly brownish; vestiture almost entirely appressed and dense, nearly concealing integument, thinnest on upper frons and around ocelli; most of clypeus and lower three-fourths of gena without appressed hairs; antennal scape, lower frons, ocellar area, and lower three-fourths of gena with conspicuous long, fully erect, sparse hairs.

Head length 1.00–1.05 times width; vertex in frontal view strongly convex, but slightly flattened behind ocelli; inner eye margins weakly convergent below, upper interocular distance about 1.1 times lower interocular distance; interocular distance (measured at level of lower margin of antennal sockets) about 3.0 times width of eye; eye length about 0.71 times head length. Clypeus strongly protuberant and convex, without longitudinal median impression; punctures of clypeus minute (0.015 mm in diameter or less), separated by 0.50–1.50 times a puncture diameter. Supraclypeal prominence largely impunctate; middle of frons subcontiguously punctate, punctures coarser than those of clypeus, becoming increasingly finer and sparser toward eye margins, finer and sparse on vertocippit, but both areas with scattered coarser punctures from which arise long, fully erect hairs; punctures of lower three-fourths of gena sparse, coarser than on vertocippit, round to oval. Antennal scape, pedicel, first flagellar segment, and dorsal part of rest of flagellum dark brownish to blackish; ratio of first four flagellar segments (measured on

shortest side of first segment): 6:6:6.5:8; median flagellar segments about three-fourths as long as wide. Labrum about twice as wide as long, convex, smooth, and glabrous, but apical margin depressed and with preapical row of short, simple, sparse, yellowish hairs, and marginal fringe of longer, simple, yellowish hairs. Preapical tooth of mandible at about distal two-thirds of mandible length. Galea brown, dorsal surface evenly and conspicuously shagreened, slightly shiny; outer margin strongly curved at apex and forming nearly right angle with straight inner edge; outer edge with fringe of short, straight hairs and a few longer hairs at apex, inner margin without fringe. Labial palpus 1.75 times length of glossa, about 0.56 times length of prementum, about 1.3 times length of maxillary palpus; ratio of lengths of labial palpal segments: 16:16:10:11.

Mesosoma: Integument shiny, dark brown to blackish. Appressed vestiture whitish, very short, and more or less obscuring integument on pronotum and mesoscutum; longer and slightly sparser on side of mesosoma, concealing integument across much of metanotum; appressed hairs of scutellum very short, but conspicuously sparser than those of mesoscutum. Long, erect, minutely barbed hairs of mesoscutum and scutellum very light brownish yellow, with some distinctly brownish near posterior margin of scutellum; those of mesepisternum longer, more abundant, whitish.

Mesoscutal and scutellar punctures subcontiguous, mostly about 0.01 mm in diameter, but with scattered larger (about 0.02 mm) punctures; mesepisternal punctures dense, with more punctures up to 0.02 mm; metepisternum similar, but punctures mostly about 0.01 mm. Propodeal triangle finely shagreened and slightly shiny, most of dorsal face finely irregularly rugulose; posterior face with dense punctures about 0.02 mm; side with obscure, extremely fine punctures.

Wings entirely clear, veins and stigma medium brown; jugal lobe about 0.70 times length of vannal lobe.

Legs dark brown. Mesotibial outer vestiture mostly silvery white, uniformly plumeous, but anteroapically with scattered amber spiniform setae; basitarsal vestiture

similar but less dense, without spiniform setae and with dense posterior fringe of long, plumose hairs; mesotibial spurs strongly bent at apex. Metabasitibial plate not visible; primary, appressed vestiture of scopa white and obscuring surface; secondary, erect vestiture brownish, long, especially along posterior margin of basitarsus.

Metasoma: Integument shiny, bright reddish, but with small, dark lateral spots on terga 2–4, and large, irregular light brownish areas at base of sterna 2–5. Terga 1–5 with apical pubescent fasciae of whitish, appressed, plumose hairs; fasciae slightly longer at sides; discs of these terga with very short, suberect, simple, yellowish hairs; tergum 1 with long, erect, minutely barbed, white hairs across basal face and terga 1–5 with similar, but fewer, hairs at each side; terga 2–4 each with single row of long, suberect, simple, brownish hairs arising along base of apical fascia, dark hairs well separated from one another and not reaching to apical margin of segment; long erect hairs of tergum 5, and all hairs of 6 fuscous. Punctures minute and dense on discs of terga. Apex of pygidial plate narrowly rounded to subtruncate; disc smooth and shiny; narrow, preapical median sulcus present but weak; area on either side slightly depressed and weakly reticulate.

MALE: Measurements (mm). Head width 1.45–1.52; head length 1.45–1.48; body length 5–6.

Head: Integument shiny black; labrum translucent yellowish; tricolored mandible black, yellowish, red. Vestiture as described for female.

Head length equal to, or slightly less than, width; inner eye margins more strongly convergent below, upper interocular distance about 1.2 times lower interocular distance; interocular distance about 3.25 times width of eye; eye length about 0.67 times head length. Clypeus slightly more protuberant than that of female, otherwise similar, except that apical one-third has only scattered punctures. Sculpture of head as in female. Ratio of lengths of first four flagellar segments: 5:6.5:11:12; middle flagellar segments slightly longer than broad. Labrum as in female except pale translucent yellow. Maxilla as in female. Labial palpus about 1.3 times length

of glossa, about 0.5 times length of prementum, and about 1.5 times length of maxillary palpus; ratio of lengths of labial palpal segments: 19:17:11:12.

Mesosoma: Integument color and sculpture as described for female. Vestiture as described for female, but short, fine, plumose hairs of scutellum almost as dense as those of mesoscutum.

Wings as described for female.

Vestiture of legs about as described for female, but spiniform setae of mesotibia fewer and less conspicuous, mesobasitarsus with only sparse, long hairs on posterior margin; long hairs fringing posterior margin of metatibia and metabasitarsus in two rows directed obliquely away from each other (i.e., analogous to setae on metabasitarsus of female) surface between these rows smooth and polished; fringe hairs dusky, but vestiture otherwise pale.

Profemur, in dorsal view, only about twice as long as thick; in anterior view, about twice as long as deep, distal two-thirds of ventral surface obliquely flattened or slightly concave. Metatrochanter with prominent, blunt, more or less conoid, ventral process at apex; metafemur, in dorsal view, about twice as long as thick; in anterior view, about twice as long as deep (fig. 20).

Metasoma: Integument shiny, dorsally black or very dark brown, ventral segments dark to medium brown. Vestiture about as described for female; terga 1–5 with distinct apical fasciae of appressed, plumose, white hairs. Punctuation as in female. Sterna 3–5 each with a mediobasal, triangular swelling, its apex directed distad; surface of swollen area smooth and shiny, without vestiture. Apical sterna and genitalia as illustrated (figs. 14–19).

TYPE MATERIAL: Holotype female and allotype: 4 mi E Willcox, Cochise Co., ARIZONA, 8 May 1986 (J. G. Rozen), in American Museum of Natural History. Paratypes (all from Cochise Co., ARIZONA): 9♀, 4♂, same data as holotype; 4♀, 1♂, same data except 16 May 1986; 7♂, same data except 17 May 1986; 4♀, same data except 5 Sept. 1986 (J. G. and B. L. Rozen); 11♀, 4♂, same data except 22 Aug. 1986 (R. R. Snelling), on *N. hispidum*; 1♀, same data except 23 Aug. 1985 (J. G. and B.

L. Rozen; 1♀, same data except 28 Aug. 1985; 4♂, Willcox, 19 May 1985 (J. G. Rozen), on *Nama hallii*; 2♂, Willcox, 19 Aug. 1985 (J. G. and B. L. Rozen), on *Nama* sp.; 2♀, same data except 19 Aug. 1983, no host; 1♂, 5♀, 4 mi E Willcox, 24 Aug. 1985 (J. G. and B. L. Rozen), on *Nama* sp.; 1♀, Willcox, 21 Sept. 1976 (J. G. Rozen); 1♂, same data except 16 May 1985; 1♂, same data except 18 Aug. 1985, on *Nama* sp. Paratypes in American Museum of Natural History and Natural History Museum of Los Angeles County.

ETYMOLOGY: The specific name refers to the modified male metatrochanter.

DISCUSSION: I have also examined three females and one male in the Museum of Comparative Zoology from 3 mi E Presidio, Presidio Co., TEXAS, collected by H. E. Evans, 23 Apr. 1963. These are the specimens recognized by G. I. Stage as representing an undescribed species.

There is very little variation in the specimens available, other than slight differences in size and color as noted in the description above.

This species is most obviously similar to an undescribed Nevada species. Females of that species are apparent oligoleges on *Coldenia*. The principal differences between *H. trochanterata* and the Nevada species are indicated in the diagnosis above. In addition, the appressed vestiture of the side of the mesosoma is much denser in the Nevada species, and almost completely conceals the surface beneath. Similarly, the fine appressed hairs of the scopa of the hind legs cover the entire outer surface of the tibia and basitarsus, except along the extreme anterior margin. In females of *H. trochanterata*, the anterior one-third of the outer face of those segments is without appressed hairs. Finally, females of the Nevada species possess a short carina at the base of the metatibia, the remnant of the posterior margin of the basitibial plate. The basitibial plate remnant appears to be wholly absent in *H. trochanterata*, or at least it is completely concealed by the dense primary vestiture of the scopa.

As does the female, the male of the *H. trochanterata* most closely resembles that of the Nevada species, from which it is immediately separable by the structure of the legs, especially of the metatrochanter. In the Ne-

vada species the profemur, in dorsal view, is about three times as long as thick and the metafemur is a little more than four times as long as thick. Tergum 6 of the Nevada species is distinctly pubescent-fasciate, but it is not in *H. trochanterata*. The glabrous basal swellings at the base of metasomal sterna 3-5 are also unique to this species.

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